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Perceptions and estimates of error rates in forensic science: A survey of forensic analysts

Disciplines

Forensic Science and Technology

Comments

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PERCEPTIONS AND ESTIMATES OF ERROR
RATES IN FORENSIC SCIENCE:
A SURVEY OF FORENSIC ANALYSTS

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Applications in Forensic Evidence

LEGAL ADMISSIBILITY OF SCIENTIFIC EVIDENCE

- Trial courts evaluate whether “an expert’s testimony pertain[s] to ‘scientific knowledge’” in part by considering the **“known or potential rate of error”**
 - U.S. Supreme Court decisions
 - *Daubert v. Merrill Dow Pharmaceuticals, Inc.* (1993),
 - *Kumho Tire Co. v. Carmichael* (1999)
 - Other countries have similar standards

WHAT DO WE KNOW ABOUT ERROR RATES?

- Historically, denial of error
- NAS (2009) emphasized need for known error



WHAT DO WE KNOW ABOUT ERROR RATES?

- PCAST (2016) reported,
 - "In response to the 2009 NRC report, the latent print analysis field has made progress in recognizing the need to perform empirical studies to assess foundational validity and measure reliability" (p. 87-88).
 - "Remarkably, there have been only two black-box studies that were intentionally and appropriately designed to assess validity and reliability"
 - Ulery et al., 2011 FBI study: 1 in 604 false positives
 - Pacheco, et al, 2014 unpublished: 1 in 24 false positives

WHAT DO WE KNOW ABOUT ERROR RATES?

- PCAST report identified only one appropriately designed study regarding firearm analysis
 - (i.e Baldwin et al., 2014 unpublished)
 - False positive errors: 1 in 66
- Studies of handwriting analysis have typically suggested that analysts offer erroneous conclusions ~40% of the time, although error rates vary widely
 - (Faigman, et al 2016).

TYPES OF ERROR

Analyst's Conclusion	Ground Truth	
	Identification (Same source)	Exclusion (Different source)
Identification	Correct identification	False Positive
Exclusion	False Negative	Correct Exclusion
Inconclusive	False Negative	False Positive

WHAT ABOUT PROFICIENCY TESTS?

- CTS reports ~ 12% of participants did not correctly identify all prints
- But, should not consider this an error rate in the field
- "This report contains the data received from the participants in this test. Since these participants are located in many countries around the world, and it is their option how the samples are to be used (e.g., training exercise, known or blind proficiency testing, research and development of new techniques, etc.), the results compiled in the Summary Report are not intended to be an overview of the quality of work performed in the profession and cannot be interpreted as such...These comments are not intended to reflect the general state of the art within the profession."
 - (CTS reports p. 1)

PUBLIC PERCEPTION OF FORENSIC SCIENCE ACCURACY

- U.S. laypersons estimate accuracy rates from 78% (alcohol/drug tests) to 95% (DNA)
 - Lieberman et al. (2008)
- U.S. laypersons estimate the false positive rate from:
 - 1 in 10 million (DNA)
 - 1 in 5.5 million (latent print)
 - 1 in 1 million (bitemark, microscopic hair),
 - 1 in 100,000 (handwriting)
 - Koehler (2017)
- Australian laypersons estimated error rates in forensic science testing ($M = 39\%$) and analysis ($M = 45\%$)
 - Ribeiro, et al. (in press).

PUBLIC PERCEPTION OF LATENT PRINT RELIABILITY

_____ believed latent print analyses were....			
	Somewhat Reliable	Reliable	Very Reliable
Laypersons	20%	51%	26%
Defense Attorneys	39%	23%	6%

Garrett & Mitchell, 2016

WHAT DO FORENSIC SCIENTISTS BELIEVE ABOUT ERROR...

CURRENT STUDY

- Forensic science analysts provide information directly to the courts, including information about error
- Efforts to reform or improve will be influenced by what forensic scientist believe about error
- So what do analysts—who actually perform analyses—believe about error?

METHOD

Participants

- 183 analysts
 - Master's degree (49%)
 - Bachelor's degree (43%)
- Grouped into 4 broad disciplines:
 - Biology (46%)
 - Pattern Evidence (24%)
 - Chemistry (18%)
 - Crime Scene Investigation (7%)

Survey

- Administered written survey during trainings
- Questions about:
 - Error rates in discipline
 - Prioritizing errors
 - Where error rates found/published

RESULTS

ESTIMATED ERROR RATES

1. Which of these is closest to the rate of **false positive** errors in your discipline? In other words, an experienced forensic scientist in your discipline would mistakenly conclude a match or identification where none truly exists approximately 1 time in ____:

- | | |
|--|--|
| <input type="checkbox"/> 2 | <input type="checkbox"/> 10,000,000 |
| <input type="checkbox"/> 10 | <input type="checkbox"/> 100,000,000 |
| <input type="checkbox"/> 100 | <input type="checkbox"/> 1,000,000,000 (one billion) |
| <input type="checkbox"/> 1,000 | <input type="checkbox"/> 1,000,000,000,000 (one trillion) |
| <input type="checkbox"/> 10,000 | <input type="checkbox"/> 1,000,000,000,000,000 (one quadrillion) |
| <input type="checkbox"/> 100,000 | <input type="checkbox"/> Less than 1 time in one quadrillion |
| <input type="checkbox"/> 1,000,000 (one million) | <input type="checkbox"/> Such an error is impossible. |

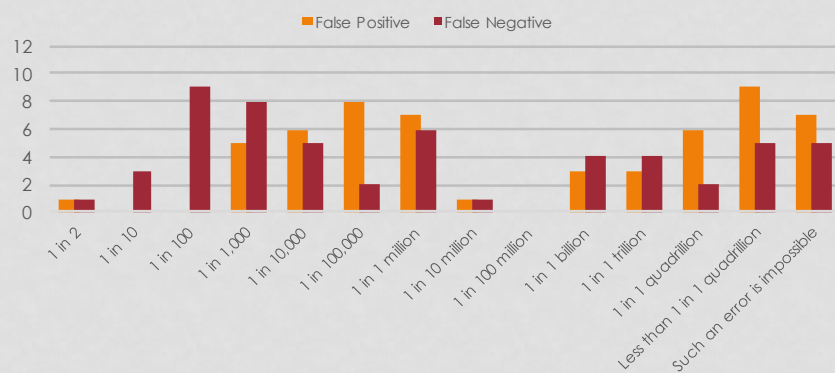
Note: Scale drawn from Kohler (2017), for comparison to layperson estimates

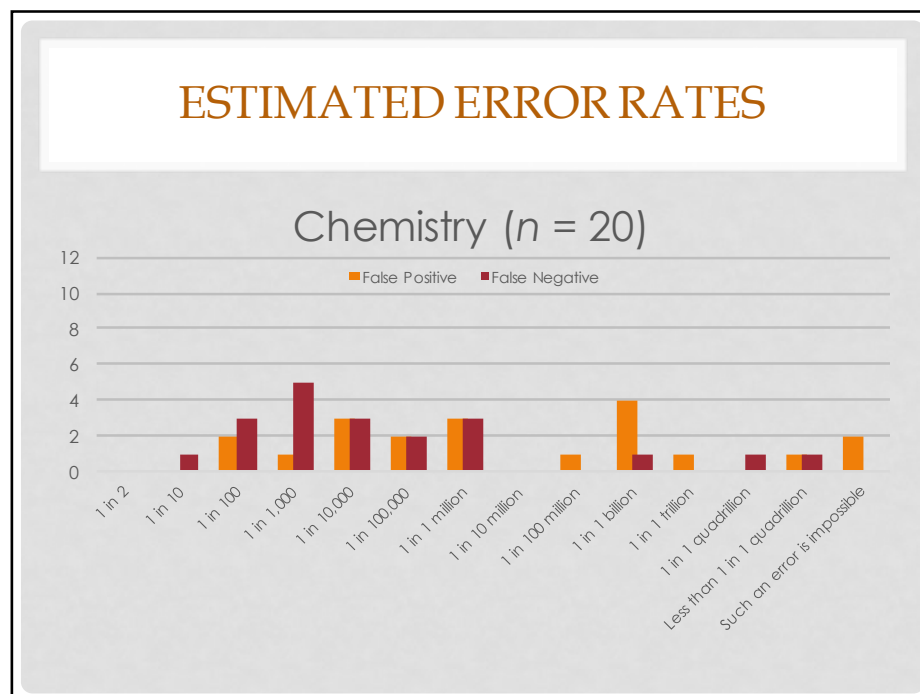
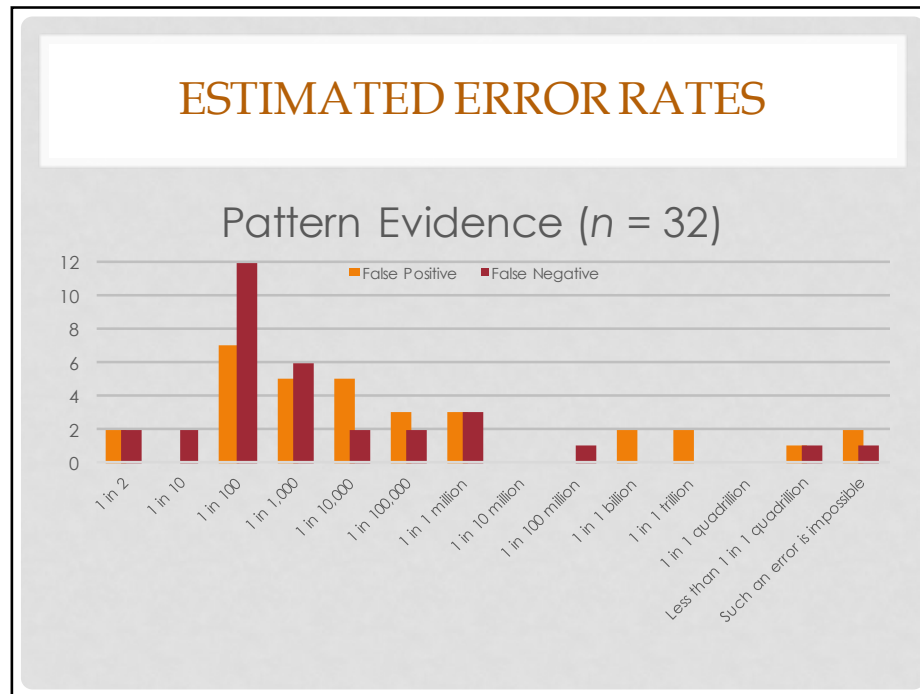
ESTIMATED ERROR RATES

- **False positives:** 1 in 10,000 (0.01% error rate)
- **False negatives:** 1 in 100 (1.0% error rate)
- Older analysts proved higher estimates of false positive and negative errors
 - 6% - 8% of variance explained by age

ESTIMATED ERROR RATES

Biology (n = 56; 55)





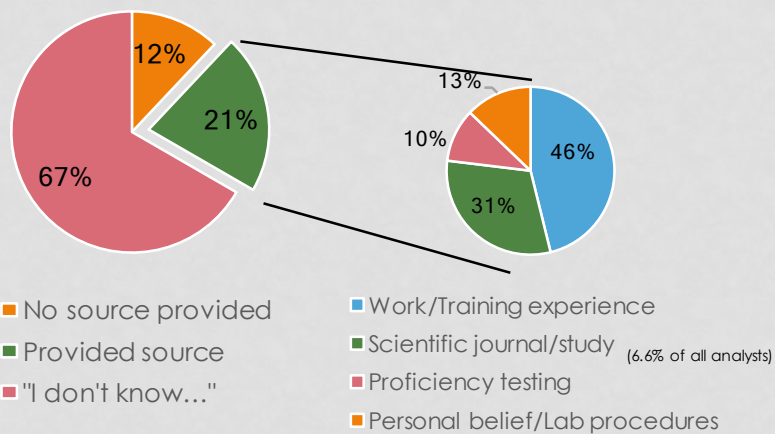
WHERE DO YOU FIND ERROR RATES?

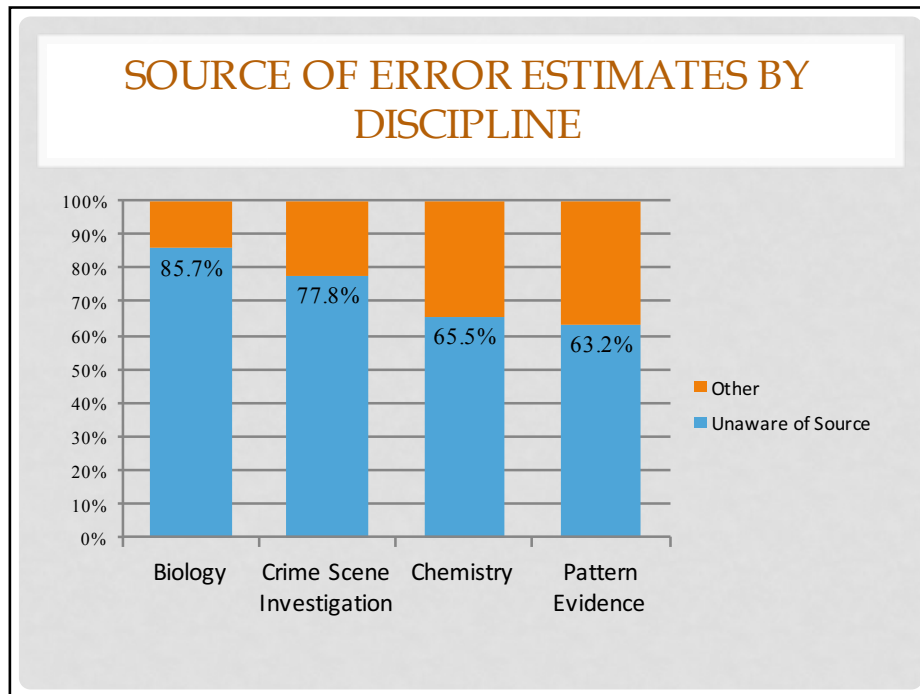
What is the basis of your reported error rates in questions 1 and 2? Please be as specific as possible (i.e., if your response comes from a specific publication or document, please identify that publication or document). Imagine that you were being asked this question in court and had to convey to the court exactly what source you used.

☐ Source: _____

☐ I do not know of any specific source that documents known error rates in my discipline.

SOURCE OF ERROR ESTIMATES





ACCEPTABILITY OF ERROR TYPES

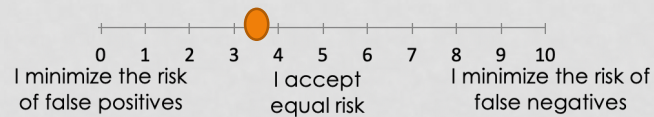
Although forensic scientists examining evidence strive for perfect accuracy, no amount of training, skill, dedication, or perseverance can eliminate all errors. In determining whether evidence does or does not support a match or identification, some cases present more of a challenge than others, and there is always at least some risk of making a wrong determination. Forensic scientists examining evidence must always balance the risk of **false positives** versus **false negatives**:

A **false positive** is the error of determining that evidence does support a match or identification, when a match or identification does not truly exist.

A **false negative** is the error of determining that evidence does not support a match or identification, when a match or identification truly does exist.

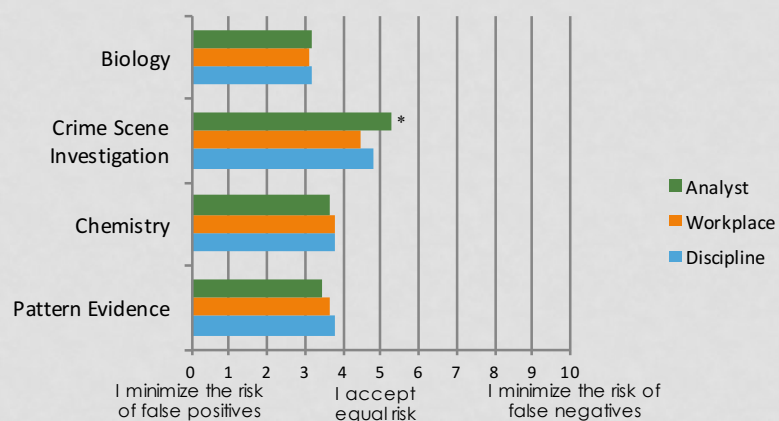
The risk of false positive and false negative errors are interrelated, such that avoiding one type of error increases the risk of the other type of error. For example, a latent print analyst who is very careful not to conclude a match exists where none exists (i.e., avoid false positive errors) is more likely to miss a match that exists (i.e., make a false negative error). Conversely, an analyst who is very careful not to miss a match (i.e., avoid false negative errors) is more likely to conclude a match exists where none exists (i.e., make a false positive error).

ACCEPTABILITY OF ERROR TYPES



- Greater work experience = Greater preference to minimize false positives and tolerate more false negatives
 - 5% of variance explained
- Analyst estimates varied according to discipline
 - 5% of variance explained

ACCEPTABILITY OF ERROR TYPES



DISCUSSION

- Analysts most commonly estimated:
 - False positive errors: 1 in 10,000 (0.01% error rate)
 - False negative errors: 1 in 100 (1% error rate).
- These rates are lower than the smallest error rates reported in the literature.
- Over 1 in 5 examiners estimated the risk of each type of error to be “impossible” or extremely low (i.e., ≤ 1 in one billion)

DISCUSSION

- *Daubert* (1993) advises judges to consider the “known or potential rate of an error” when admitting scientific evidence.
- Analysts provided widely divergent estimates of error in the same fields—with some estimates impossibly low.
- Most analysts could not identify where error rates for their discipline were published or available
 - <7% could identify a study or document

DISCUSSION

- The field has limited data on error rates in some disciplines
- But such data is becoming available
- Analysts were rarely familiar with the details of this data
- Rather, they tended to estimate error rates were quite low
- These estimates may be what are conveyed to courts, and what motivate improvement efforts...



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